

The progress of the world during the last half-century becomes strikingly evident if one reflects how very different the lectures would have been if the course had been delivered fifty years ago. Apart from the enormous expansion of the coal trade, various great industries have arisen due to the working of minerals which were unknown, or little used, at the time of the Great Exhibition of 1851. It is only necessary to refer to the petroleum of Russia and the United States, the potash salts of Germany, the borates of California, the nitrate of soda of Chili, and the phosphates of various countries.

The provision of a cheap and convenient illuminant like petroleum may seem a small matter to the present generation of town-dwellers accustomed to the electric light or to Welsbach burners; but those whose memories go back to the days of the guttering "dip" and its snuffers can realise what petroleum has done for the winter evenings of our villages and those of distant lands; and, of course, petroleum has many other uses.

Mr. Brough has not confined his lectures to a mere compilation of published information. His own extensive travels enable him to give descriptions of various workings which he himself has visited, and, in addition, he has been able to obtain accounts from competent observers on the spot, and to illustrate them by reproductions of photographs. We learn from the accompanying figure, reproduced from Mr. Brough's paper, that magnesite is quarried in a primitive fashion at Salem, which lies half-way between Madras and Beyport. The stone is carried away on the heads of women to the mills. The Indian magnesite is exceedingly pure, and therefore admirably adapted for the manufacture of fire-bricks.

The last lecture contains not only many interesting details concerning gem-mining, but also affords useful information concerning the sources of thoria, now in demand for the manufacture of incandescent mantles.

The addition of a complete index considerably enhances the value of the pamphlet.

### OBSERVATIONS OF THE PLANET JUPITER.

JUPITER has now approached so near to the sun as to be invisible for all practical purposes, and observers must wait until the mornings of next June before telescopic work can be renewed with prospective success.

The study of his surface markings during the past nine months has evolved some interesting facts which will prove useful for comparison with those obtained in preceding years. It is from the continued study of Jovian features during many successive oppositions that we may hope to learn something more definite as to the nature of the curious phenomena operating on his surface.

Essentially different in its aspect and character from the more durable lineaments observed on Mars, the scenery of Jupiter consists of variable bands of light and dark material circulating round the great planet at dissimilar periods. Apparently we see nothing of Jupiter's real surface formations; the belts and zones exhibited in our telescopes represent vapours spun into parallels of latitude by the rapid rotatory motion of the globe beneath.

The study of Jupiter is chiefly directed towards determining the rate of motion of the various currents and to noting the more active regions and forms and tints of the principal features. During the last half of 1903 the red spot appeared to be a little plainer than during the few previous oppositions, and it exhibited a decided retardation of velocity, its rotation period being 9h. 55m. 41.6s., as in the last few years of the nineteenth century.

The equatorial spots, of which there were about twenty-eight fairly conspicuous examples presented, gave a rate of 9h. 50m. 27.9s., agreeing very closely with the mean value for the previous six years.

The south temperate spots travel from year to year at a very uniform rate of motion, and this was further exemplified in 1903, the mean period of nine spots being 9h. 55m. 18.5s.

The north temperate spots moved more slowly than any others on the disc, the rotation of nine objects in this region averaging 9h. 55m. 54.3s.

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A number of large dusky spots were seen in high northern latitudes in 1903. Some of these in about lat.  $+55^\circ$  were carefully watched, and their periods were found nearly conformable with the period of the red spot.

A few irregular markings were observed in the region of the north and south poles, but owing to the bad definition usually prevailing, a sufficient number of observations of them could not be secured. During the last five months of 1903 the weather conditions were usually bad, and very delicate planetary features were obliterated on the very unsteady, indistinct images. Between 1903 May 26 and 1904 February 2 I examined Jupiter on 109 nights, the definition being noted as "bad" or "very bad" on 58 nights, while it was recorded as "good" or "very good" on 30 nights only. In all, 1388 transit times of various spots were secured, and the rotation periods of seventy different objects determined.

W. F. DENNING.

### UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The degree of Doctor of Science, *honoris causa*, is to be conferred on Dr. Wilhelm Ostwald, professor of chemistry in the University of Leipzig.

Mr. H. Y. Oldham, King's, has been appointed to the readership in geography for a period of five years, under the new conditions.

Mr. F. Horton, B.A., St. John's, has been elected to the Allen studentship of 250l. for research in experimental physics.

THE Senate of Aberdeen University has agreed to confer the degree of Doctor of Laws upon Sir George Watt, the officer in charge of the Industrial Museum at Calcutta, and Prof. Wyndham R. Dunstan, F.R.S., director of the Imperial Institute.

THE Senate of Glasgow University has resolved to confer the honorary degree of Doctor of Laws on Mr. G. F. Deacon, civil engineer, London; Dr. W. Stirling, Brackenbury professor of physiology and histology at Owens College, University of Manchester; and Sir William Taylor, Director-General of the Army Medical Service.

AN examination in biological chemistry will be held at the laboratories of the Institute of Chemistry in October next. The examination will extend over four days, and may be theoretical, practical, written and oral. The syllabus will include biological chemistry, with special reference to the chemistry and bacteriology of foods, water, sewage and effluents, and to the practical applications of biological chemistry to industries.

THE Board of Education has approved the draft scheme for the Education Committee for London, submitted by the County Council. The education authority for the metropolis will thus not include members co-opted on account of special knowledge or experience of educational problems. The letter from the Board of Education contains the remark that "In expressing their approval, the Board must not be understood to accede without regret to the desire of your Council to limit the Committee so closely to members of their own body."

A REUTER message from Calcutta states that the Indian Government has issued the text of a resolution of some length dealing with Lord Curzon's scheme for the reform of education. From this it appears that after an exhaustive history of the subject, the Government states that the existing methods require sweeping changes, and goes on to announce that competitive examinations for the public services will be abolished and a system of selection of candidates on probation substituted. "Examinations," it is added, "have harmfully dominated the education system." The Government admits that primary education has been neglected, while secondary education has increased in a striking manner. The college curriculum will be generally raised, the Government assisting deserving colleges. Teachers will be specially trained, and the Education Department will be given four extra officers to assist the present

directors. Questions relating to commercial, technical, artistic, and agricultural training are fully discussed in the resolution.

A NEW building, called Palmer Hall, which has been opened at Colorado College, Colorado, has cost more than 50,000l., and is to be devoted chiefly to the scientific departments. The dedicatory address was delivered by the president of Stanford University, Dr. D. S. Jordan, who in the course of his remarks said:—"As the university ideal of England is one of personal culture, that of Germany is one of personal knowledge. An educated German may lack culture—of this there are many conspicuous examples, just as in England a cultured gentleman may lack exactness of knowledge on all points. In America, a new ideal is arising as a result of the creative needs of our strenuous and complex times. We value education for what can be made of it. Our idea is personal effectiveness. We care less and less for surface culture, less and less for mere erudition. We ask of each man not what he knows, but what he can do with his knowledge. This ideal of education has its dangers. It may lead us to sacrifice permanent values for temporary success. It may tend to tolerate boorishness and shallowness, if they present the appearance of temporary achievement. But the fact remains, the value of science lies in its relation to human conduct. The value of knowledge lies in the use we can make of it. As each thought of the mind tends to work itself out in action, so does each accession of human knowledge find its end in fitting men to live saner and stronger lives. We may, therefore, rest content with the ideal of effectiveness."

#### SOCIETIES AND ACADEMIES.

##### LONDON.

**Royal Society, February 18.**—"Note on the Formation of Solids at Low Temperatures, particularly with regard to Solid Hydrogen." By Morris W. Travers, D.Sc., Professor of Chemistry at University College, Bristol. Communicated by Sir W. Ramsay, K.C.B., F.R.S.

In the year 1902 Dr. Jaquerod and the author carried out some experiments on liquid and solid hydrogen with the view of determining its vapour pressure on the scales of the constant-volume helium and hydrogen thermometers. They found that hydrogen remained liquid down to  $14^{\circ}2$  (He scale), the lowest temperature to which they could reduce a large mass of the liquid by means of the pump at their disposal. When, however, a small quantity of liquid hydrogen, cooled to  $14^{\circ}2$  in a glass tube immersed in the liquid contained in the large vacuum vessel, was allowed to evaporate under reduced pressure, it solidified when the pressure fell to 49 or 50 mm. of mercury. This pressure corresponds to a temperature of  $14^{\circ}1$  on the helium scale. The presence of the solid was determined by mechanical means, and it was not possible to observe its appearance.<sup>1</sup>

Dewar gives the melting point of hydrogen at about  $15^{\circ}$  absolute, and the melting pressure at 55 mm. of mercury. He describes its appearance as that of "frozen foam," or as "clear transparent ice."<sup>2</sup>

It appeared to the author worth while to carry out a few experiments to try to determine whether solid hydrogen formed definite crystal, or, indeed, whether the glassy substance was a true solid or merely a highly viscous fluid. The following is an instance in which both such changes occur.

If an organic liquid, such as ethyl acetoacetate, is cooled slowly to the temperature of liquid air it is converted into crystalline solid, the formation of the crystals commencing when the liquid is cooled to about  $-150^{\circ}$  C., usually at several points on the side of the vessel, and spreading rapidly throughout the mass. If, on the other hand, the liquid is cooled very rapidly, a hard glassy substance is formed, and though crystals may begin to appear, they will only do so locally, as the velocity of crystallisation decreases rapidly as the viscosity of the liquid increases. The glassy substance is really a liquid of high viscosity; it is formed

with perfect continuity from the normal liquid state, and should differ from the solid (crystalline) form in its physical properties. Such a substance might, for convenience, be called a pseudo-solid.

In the investigation of solid hydrogen the apparatus shown in the accompanying figure was employed. The liquid hydrogen was introduced into a small clear-glass vacuum-vessel 15 cm. long and 4 cm. in internal diameter. This vessel was placed inside a glass tube BB, which communicated with an exhaust pump through a tube DD sealed to it, and was closed by a rubber stopper C. A short glass tube E, 6 mm. in diameter, passed through the stopper, and through it passed the stirring rod FF. To allow of free rotating motion to the stirrer, and to make the apparatus gas-tight, a short piece of rubber tube G was passed over the end of the tube E and was wired to F. The lower part of the apparatus was contained within the vacuum vessel H, which contained a small quantity of liquid air.

When the liquid hydrogen was made to boil *in vacuo*, its temperature fell, but the liquid did not appear to become more viscous. At length films of a colourless glassy substance formed at the surface, and broke away as the bubbles rose. After a short time the vessel became filled with these flakes, and while in this condition stirring, by giving the top of the rod F a rotatory motion, did not appear to indicate that the portion which remained liquid had undergone any considerable increase in viscosity. After a time the mass contained so much solid that it became pasty, and finally the whole of it appeared fairly homogeneous.

The solid evaporated fairly rapidly, so that after about ten minutes only a hollow cylinder of it, about 3 cm. long and 2.5 cm. in diameter, remained. This had the appearance of a film of ice which had partly thawed, consisting of clear granules connected by thinner and less transparent portions of solid. No crystals were observed on either of the three occasions on which the experiments were carried out. An attempt was made to examine the solid in the field of a polariscope, but it was unsuccessful.

Though there is no direct evidence of the formation of crystalline hydrogen, the author's experiments lead to the belief that solid hydrogen is a crystalline substance and not a pseudo-solid. The sharpness with which the solid hydrogen is formed, and the constancy of the apparent melting pressure, are distinct evidence in favour of this conclusion, though it must be allowed that the rate of change in viscosity, when the temperatures are measured on the Centigrade scale, will probably appear to be more rapid at low temperatures than at high temperatures.

The whole question of the formation of solids at very low temperatures is of great interest both from a physical and from a biological standpoint. It is quite possible that if living organisms were cooled only to temperatures at which physical changes, such as crystallisation, take place with measurable velocity, the process would be fatal, whereas if they once were cooled to the temperature of liquid air, no such change could take place within finite time, and the organism would survive.<sup>1</sup>

These experiments were made in connection with some investigations which were being carried out at University College, London, with the assistance of a grant from the Royal Society. As the author is at present unable to continue the work, he has decided to publish this note.

<sup>1</sup> Experimental results are given by Macfadyen, Roy. Soc. *Proc.*, vol. lxxvi., 1900, pp. 180, 339, 488; Swinbank, Roy. Soc. *Proc.*, vol. lxxviii., 1901, p. 502.

<sup>1</sup> *Phil. Trans.*, A, vol. cc., p. 170.  
<sup>2</sup> British Association, Presidential Address, 1902. See also paper on "Solid Hydrogen," Brit. Assoc. Report, 1899, reprinted in *NATURE*; also Roy. Inst. *Proc.*, 1900.